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Information flows and smart disclosure of financial data: A framework for identifying challenges of cross boundary information sharing

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ABSTRACT

The governance of financial markets in the U.S. is structured around financial products which in some cases results in overlapping regulatory responsibility, intricate and complicated relationships among the various parties and role confusion. These intricate relationships are often complicated by informal and ad-hoc information sharing practices across the regulators. This situation has been recognized as contributing to financial market risks and limiting the potential of smart disclosure policies to benefit financial market stakeholders. This paper adapts an existing framework for information sharing and integration to the complex environment of financial market regulation (FMR) to present an argument for the criticality of effective cross-boundary information sharing to financial regulators seeking to establish robust governance of financial markets. The framework is then used to outline the challenges to information sharing and integration in FMR and to help model the related information flows. Current literature and a recent study of information sharing in FMR are used to identify key actors in FMR information sharing relationships to outline the challenges faced in this unique context and the resulting risk if these challenges go unaddressed. In addition, this paper showcases an example of smart financial apps to illustrate the potential impact of information sharing and integration challenges on smart disclosure policies.

1. Introduction

Non-systematic and ad-hoc information sharing practices among financial market regulatory agencies are regarded as key contributors to the 2008 financial crisis (BIS, 2010; Bradley, 2011; Brummer, 2010; FSB, 2011; IMF, 2007; Pardo, Sayogo, & Canestraro, 2011; Tarullo, 2010). The crisis was a case in point of how ineffective information sharing hinders supervisory authorities from detecting vulnerabilities in global financial markets (IMF, 2007). But the impact of constrained and ineffective information sharing on market regulation was well-known long before 2008. A 2004 report by the U.S. Government Accountability Office (GAO) cited vulnerabilities caused by gaps in information sharing and integration, and called for routine and systematic information sharing across financial regulators (GAO, 2004). The critical nature of effective information sharing for monitoring of financial markets, and the consequences of gaps in such capability, are also increasingly recognized by a range of national and international organizations (BIS, 2010; FSB, 2011; IMF, 2007). Information exchange standards, expanded sharing of more detailed data and cross-border cooperation are considered to be necessary for making information sharing possible, and ensuring that financial regulators meet their responsibilities.

This conceptual paper describes the challenges facing systematic information sharing in the financial market regulation (FMR) context, and aims demonstrates the benefits of improved information sharing through smart disclosure of financial data. Our work is based on a combination of in-depth literature review and an overview of one case study of smart disclosure of financial data. While previous work touched upon some FMR challenges, including the role of effective information sharing (e.g. Pardo et al., 2011), identification of those involved in the sharing relationship, their role in sharing processes, and the challenges and risks to the sharing process in the context of FMR are only partially understood. We review extant literature to map current actors in FMR, specify their relationships to each other, and identify challenges and risks accompanying information sharing for each of the actors. This paper uses the model of inter-agency information integration and sharing proposed by Gil-Garcia, Pardo, and Burke (2010) to frame our discussion. The framework focuses on systematic inter-governmental

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information sharing, which makes it particularly relevant for understanding of FMR. Other information sharing frameworks focus mainly on private entities (eg. see Park, Gu, Leung, & Konana, 2014; Sun & Yen, 2005), collaborative partnerships (eg. see Dantas & Seville, 2006), or the technical aspect of information sharing (eg. see Liu & Chetal, 2005).

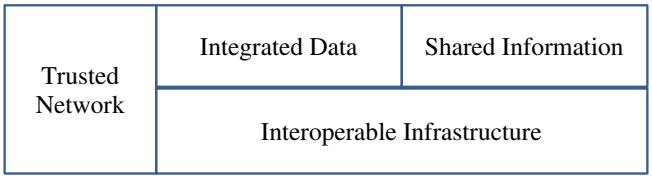
The paper also discusses the likely effects of systematic information sharing challenges on smarter governance of financial markets by showcasing an example of a smart application for financial data. In this paper, smart financial applications, or more popularly and herein, shortened as "apps", are defined as software applications used on mobile devices or via an online browser that enable processing of financial data to support consumers making smart decisions. We argue that the implementation of smart disclosure in FMR could facilitate the creation of smart monitoring and oversight through smart mobile or web financial applications, thus improving the governance of financial markets. As argued by Lee, Hancock, and Hu (2014), the forefront of smarter government innovations is the technological or instrumental dimensions which refers to the applications and tools for delivering the smart services. We thus posit that smart apps add additional layers of monitoring and complement the effectiveness of monitoring and oversight by financial regulators. Smart apps are designed to change complex financial information into manageable and easy to understand information which then minimizes the occurrence of financial fraud and wrong investment. Through smart apps, the "general" investor could make investment decisions more wisely and evaluate financial product offerings more thoroughly.

The remainder of the paper is organized into five sections. Section two introduces the information sharing and integration framework used to frame our discussion, as well as an overview of smart disclosure policy and open data based financial tools. Section three describes the research approaches used in this paper focusing on the identification of the literature and the case selection. Section four starts with an introduction of the primary actors in FMR information sharing followed by a discussion of the challenges facing FMR in their efforts to share information. Section five demonstrates the benefits of cross-boundary information sharing in facilitating smarter disclosure of financial data and how such disclosure can support public innovation and lead to smarter governance. Section six provides concluding remarks, future research direction and practical advice that government managers may take into account to help them understand the challenges of and capability needed for systematic information sharing in financial market regulation.

2. Information sharing and integration framework and smart disclosure

2.1. Information sharing and integration framework

This paper uses the Gil-Garcia et al. (2010) framework to examine information sharing in FMR. This framework considers the complexities inherent in Cross Boundary Inter-agency Information Sharing (CBIIS) and the social and technical elements important to its understanding (Pardo & Tayi, 2007). Gil-Garcia et al. (2010) used extensive literature review and findings from eight case studies of inter-agency information sharing as the basis for their framework. Gil-Garcia et al. conceptualized an integrative framework for information sharing (Fig. 1) comprised of four components: a) interoperable technical infrastructure, b) integrated data, c) shared information, and d) trusted social network.



Source: adapted from Gil-Garcia et al., 2010

Fig. 1. Four components of inter-agency information integration and sharing.

The first component, interoperable technical infrastructure (a), is the most critical element for systematic sharing and integration of information across different agencies (Pardo, Gil-Garcia, & Burke, 2008). Gil-Garcia et al. (2010) identified the importance of technical aspects of interoperability for both hardware and software. They argue that despite the technical difficulties in developing interoperability, an interoperable system is found to make sharing information easier and provide accurate, protected, and usable information.

The second component, integrated data (b), is critical for sharing information among multiple organizations particularly when information to be shared is in different formats. Different data formats restrict the comparability of information and limit capability for integration. The authors claim that common data elements will significantly improve sharing and integration of information across organizational boundaries (Gil-Garcia et al., 2010).

The third component is shared information (c). Gil-Garcia et al. argue that shared information represents the identification of tacit and explicit knowledge in agencies. Such identification of knowledge is essential to effective information sharing in two ways. First, identification and understanding of shared information across different agencies is essential to frame the design of information sharing systems. Second, assessment of shared information provides an initial step to building integrated data through the identification and classification of shared information against information that is not yet shared. They further argue that assessment of currently shared information will facilitate understanding of the breadth and scope of proposed information sharing systems (Gil-Garcia et al., 2010). Such assessment, they argue, will influence the amount of needed resources, the sophistication of information sharing strategies, the complexity of technical requirements, and the shape of information sharing policies.

The fourth component is trusted networks (d). Trust among sharing partners is considered a prerequisite to successful sharing (Pardo, Gil-Garcia, & Burke, 2008; Pardo, Gil-Garcia, & Luna-Reyes, 2008). A network of trusted actors significantly influences the effectiveness of communication and reduces resistance to information sharing. Additionally, the level of trust is important to reducing turf barriers and concerns over information misuse (Gil-Garcia et al., 2010).

2.2. Smart disclosure of financial data

In January 2009, the Office of Information and Regulatory Affairs (OIRA) of the U.S. Office of Management and Budget issued a Memorandum on Disclosure and Simplification as Regulatory Tools. The memorandum provides guidance for the use of disclosure as a regulatory approach, including "smart disclosure" policy. Smart disclosure is defined as "timely release of complex information and data in standardized, machine readable formats in ways that enable consumers to make informed decisions" by providing information upon which choices can be made by the public (Sunstein, 2011). The basic premise of smart disclosure is giving more power to the general public by transferring control of personal data from the hands of corporate interests to the public (Cobb, 2012). It is argued that by providing more control of information to the public, smart disclosure has the potential to promote innovation, economic growth and job creation. Smart disclosure was initially applied in the field of energy consumption (Green Button) and health services (Blue Button), and consequently used in various areas including commerce, education, safety, and global development and finance.

Proponents of smart disclosure argue that such policies can also be used to help consumers in making informed decisions with regards to financial products (Willis, 2013). Extant literature posits that consumers' decisions are commonly affected by behavioral biases resulting

Table 1
Comparison of existing smart apps and tools for financial data.

		Functionality	
		Information aggregator	Information comparison
Output	Comparing/gathering	*FindTheBest* — a web application that combines data from U.S. Securities and Exchange Commission (SEC), the U.S. Department of Education, and other public sources to gather facts and compare different products and services for a wide range of products and services including finance.	*CalcBench* — a web application that offers tools to analyze, compare, and understand companies financial reports in XBRL as reported to the SEC. BillShrink, Personal Capital
	Advising	*BillGuard* — an application that offers ratings on 401(k) and 403(b) plans as well as data on financial advisors based on numerous sources including SEC and FINRA. *BrightScope* — an application that draws from bill dispute data on the web, banks and the open consumer complaint database in Consumer Financial Protection Bureau to offer identification of gray charges on users' credit and debit cards.	*SigFig* — a web application providing personalized advice on investments and fees based on SEC data on mutual funds and exchange-traded funds. *HelloWallet* — an application that extracts data from federal sources to offer users financial guidance in various aspect of life including buying home, retirement, debt reduction and others.

from information overload and aversion to complexity (McKee, 2012) that consequently cause consumers to make undesirable choices (Thaler, 2013) including financial ones. Smart disclosure of financial data, as argued by its proponents, has the potential to advance financial education and financial literacy efforts through the provision of simple tools and apps that reduce complexity and information overload and facilitate good financial decision making. There are numbers of applications and tools built on smart disclosure for financial data. The site Highlights.Data.Gov (http://highlights.data.gov/), designed to showcase the best Open Data resources, lists several tools, datasets and applications that are useful in this regard, such as SigFig, FindTheBest, CalcBench, BillShrink, BillGuard, BrightScope, Personal Capital and HelloWallet. We argue that these tools and apps can be categorized based on three factors: functionalities, outputs and the types of data they use.

In Table 1, we categorized the apps and tools based on their functionalities and outputs. Functionalities refer to the main function of the apps or tools while outputs refer to the end results of the function. We propose two main functions — information aggregation and information comparison. Information aggregation refers to apps or tools that amass large amounts of data or information gathered from various sources and present aggregated information to the user (Zhu, Siegel, & Madnick, 2001). Information comparison apps or tools provide comparative capability of information and data collected from various sources. In addition, we argue for two main outputs — advising and comparing and gathering. Comparing and gathering refer to apps and tools that simply compare or gather range of information and do not provide any advice based on their comparison. Advising refers to apps and tools that provide advices and recommendations to the users based on the result of information aggregation or comparison.

Apps can also be classified based on their data sources into apps and tools that use only government data, and apps and tools that combine government data and non-government sources such as data from NGOs, private entities and activists (Table 2). Apps and tools like SigFig, CalcBench, Personal Capital and HelloWallet only use data published by government agencies (highlights.data.gov). For example, CalcBench only uses financial reports published by the SEC in XBRL format; Personal Capital uses data published by the U.S. Department of Labor. On the other hand, apps and tools such as FindTheBest, BillShrink, BillGuard and BrightScope amass data from government-published sources as well as public-source data. For example, BillGuard draws from Consumer Financial Protection Bureau complaints as well as data from the web.

3. Research approach

This paper is based on a combination of in-depth literature review on FMR and information sharing, and a detailed case study of smart disclosure of financial data.

3.1. Literature mapping

The literature review encompassed three areas: literature on interagency information sharing and integration, literature and professional reports on information sharing challenges in financial markets, and previous work by Pardo et al. (2011) on the challenges facing 21st century financial market regulators detailing the result of interviews with FMR professionals. We used three approaches to guide us in identifying the literature for the first and second sources: First, we searched using free search engines such as Google Scholar and databases such as Science Direct. We used keywords such as "information sharing in financial markets", "financial regulatory information sharing", or "information sharing AND financial market regulators". Second, we then reviewed citations from the identified literature. Finally, we used the e-government literature database of the DGS (Digital Government Society) of North America released in March, 2011.

3.2. Case study of smart disclosure of financial data

We initially identified instances of the smart disclosure of financial data from the site http://highlights.data.gov. Subsequently, we cross-checked the apps and tools identified from highlights.data.gov with the tools and apps listed in two communities in data.gov, namely: business and consumer communities. We then selected BrightScope for our case study evaluation because it is considered an exemplar of smart disclosure implementation in the financial domain (Howard, 2011; Lieber, 2011), and because enough is known about its story to allow identification of information sharing challenges of smart disclosure in the financial arena. In addition to BrightScope, we use information from other financial smart apps identified from highlights.data.gov, the business and consumer community, and the top ten smart financial apps listed in CNN money.com.

4. The challenges of systematic information sharing in fmr context

4.1. Key actors in financial market regulation

Financial market regulation in the U.S. is fragmented with multiple actors responsible for regulating various segments of the financial industry (Pan, 2009). In some cases regulatory responsibility is overlapping, resulting in a web of interconnections and intricate relationships which is then further complicated by informal and ad-hoc information sharing practices (Pan, 2009). To begin to understand the FMR context and unpack the unique and overlapping regulatory responsibilities it is necessary to identify the key actors in the FMR environment. We identified five major actors through our research, namely: federal agencies, state governments, self-regulatory organizations (SROs), financial industry entities (firms, investors, rating agencies), and the public.

SROs are self-regulating agencies that exercise some degree of regulatory authority over the financial market industry and professionals. One example of an SRO in the U.S. is FINRA (the Financial Industry Regulatory Authority). FINRA is an independent regulator for securities firms listed and doing business in the U.S. with the mission to protect America's investors (www.finra.org). To a certain extent, SROs are allowed to generate supplementary rules and policies (Jasanoff, 2006), thus serving to supplement government regulation. For instance, FINRA is allowed to generate policies and rules for broker–dealer and trading markets. SROs also cover the gaps in government oversight and regulation caused by limited direct intervention by government in an open market such as U.S. (Coglianese, Healey, Keating, & Michael, 2004).

Each actor has different roles and responsibilities with important and unique relationships among them. Extant studies argue that the sharing relationships among these actors face a variety of challenges. The challenges recognized include lack of authority, multiple overlapping jurisdictions, security and sensitivity of information, and protection of turf (GAO, 2004, 2009; Pardo et al., 2011). In the next section, we enrich the extant studies by expanding the identification of challenges using the cross boundary information sharing and integration framework proposed by Gil-Garcia et al. (2010).

4.2. Challenges to FMR information sharing

The need for information sharing capability is not unique to the context of FMR. Public health, human services, and public safety are just three of the many policy domains that require effective information sharing across boundaries of organizations and jurisdictions and across levels of government. For example, creating capability for routine and systematic information sharing has long been a priority for the U.S. justice community and one of the products of these efforts is the National Information Exchange Model (NIEM), a national program supported by the U.S. federal government. Insights from these efforts and others are increasingly available in both the practitioner and academic literature as resources to inform and guide information sharing efforts in other domains. We structure the discussion of the challenges following the four components of the Gil-Garcia et al. (2010) framework: interoperable infrastructure, shared information, integrated data, and trusted social network.

4.2.1. Interoperable infrastructure

The first category of challenges is interoperable infrastructure. While Gil-Garcia et al. (2010) focus specifically on the interoperable technical infrastructure, interoperable infrastructure requires not only interoperability in terms of technology but also management and policy (Pardo & Burke, 2008b). This is necessary because application of any information technology is nested within a particular organizational, sociological, ideological and political context (Dawes, Cresswell, & Pardo, 2009), which necessitates an understanding of the different business processes and practices within the actors' organizations and in the broader context within which they operate (Dawes et al., 2009). Thus, successful cross-boundary information sharing requires consideration of four issues of management and policy interoperability.

a. *Organizational culture*. An examination of information sharing in the criminal justice arena indicated that differences in agency culture are a significant barrier to inter-agency information sharing (Pardo, Gil-Garcia, & Burke, 2008). Successful sharing requires the identification, understanding and accommodation of existing organizational cultures within each agency to reduce resistance to sharing information. This is important to developing a shared understanding of terms, concepts and information used and available within each agency (Dawes et al., 2009), particularly considering that information is not objective, neutral or readily available within each agency (Radin, 2006).
b. *Leadership commitment*. Organization leaders must first understand the information sharing capability found in each sharing partner. This is because information sharing capabilities are dynamic, varied, complementary and multi-dimensional in nature. Leaders must assess the capabilities held collectively by the network to ensure the relevancy and appropriateness of capability to become interoperable (Pardo, Gil-Garcia, & Luna-Reyes, 2008).
c. *Capability to create effective collaboration*. This capability includes five dimensions: business model and architecture readiness, strategic planning, collaborative readiness, organization compatibility, and project management (Pardo & Burke, 2008b; Pardo, Nam, & Burke, 2012). Strategic planning is important for clarifying roles and responsibility among participants (Pardo, Cresswell, Dawes, & Burke, 2004) and to alleviate resistance to change and incompatibility of technology (Ding, Levin, Stephan, & Winkler, 2010). Assessment of business models is necessary to describe service and operational components of the organization, their relationship, and the technology used for implementation (Mayer, Davis, & Schoorman, 1995).
d. *Capability to develop new systems and procedures*. This capability is comprised of six dimensions, including: data assets and requirements, information policies, resource and project management, and technology readiness (Pardo & Burke, 2008b; Pardo et al., 2012). Data assets and requirements and information policies include data governance and policies. Development of policies for data stewardship and use (Dawes, 2010a, 2010b) is needed to facilitate efficient resource allocation.

4.2.2. Integrated data

There are two issues of importance related to the integrated data components in identifying information sharing challenges for FMR, linked data and data integrity and quality.

a. *Ensuring data quality and integrity*. High quality data is central in financial markets since it influences the success of any type of risk management activity (Jenkinson & Leonova, 2013). There are two issues with ensuring data quality and integrity in financial markets: heterogeneous data sources and a vast volume of data. Heterogeneous data sources entail the risk of integrating many different

Table 2
Data sources of selected smart apps and tools.

Apps and tools	Data sources	
	Data published by government agency	Non government sources
SigFig (www.sigfig.com)	√	
FindTheBest (www.findthebest.com)	√	√
CalcBench (www.calcbench.com)	√	
BillShrink (www.billshrink.com)	√	√
BillGuard (www.billguard.com)	√	√
BrightScope (www.brightscope.com)	√	√
Personal Capital (www.personalcapital.com)	√	
HelloWallet (www.hellowallet.com)	√	

data management cultures, policies and protocols and represent a significant cost (Pardo et al., 2011). Vast amounts of data require whole new classes of technology and new approaches to data management.

b. *Developing linked data*. Standardization and linked data are hailed as crucial factors necessary for improving oversight mechanisms in financial markets (Tarullo, 2010) in terms of standardizing quality and format of data needed for oversight and enforcement. As argued, differences in metadata and data formats restrict interoperability and sharing (Mayer et al., 1995). Standard language development is argued to support efforts to control systemic risks by enabling data aggregation, interpretation, and analysis across different sources and formats (Engle & Weidman, 2010). In terms of technology, semantic web tools such as ontology it's argued enable the creation of a "shared and common understanding of a domain that can be communicated between people and application systems (Davies, Fensel, & Van Harmelen, 2003)" and support data translation and queries from different system designs (Lumsden, Hall, & Cruickshank, 2011). Effort toward developing linked data for financial markets is already being invested in. For instance, O'Riain, Harth, and Curry (2012) propose a linked data-driven information system for integrating financial data from multiple web sources.

4.2.3. Shared information

The challenges confronting agencies as they work to share information with other entities range from technical to political and managerial, such as protecting what they see as their own turf (Gil-Garcia, Schneider, Pardo, & Cresswell, 2005) for the fear of losing relevance to the market (Pardo et al., 2011). There are five major challenges confronting financial regulators in integrating and sharing information across different regulators.

a. *Collaborative governance structure and sharing strategies*. In the criminal justice case, Gil-Garcia et al. (2005) found that agencies might oppose information sharing to protect their autonomy. A similar situation was found by Pardo et al. (2011) for FMR where the regulators resist sharing information to protect their reputation. In particular, the resistance due to the fear of losing their relevance to the market and losing power over the market (Pardo et al., 2011). One of the strategies to reduce the risks of information sharing proposed by Pardo, Gil-Garcia, and Burke (2008) is through the development of an effective collaborative governance structure organized around the expectation that agencies will be sharing information. They further outline six determinants of an effective collaborative governance structure: 1) knowledge of information needs, 2) knowledge of the environment, 3) willingness to accommodate the diversity of participating organizations and their goals, 4) knowledge about participating organizations, 5) existing legislation, and 6) executive involvement (Pardo, Gil-Garcia, & Burke, 2008). In addition, leadership and authority from the top levels of government are needed to facilitate effective sharing in a multi-agency information sharing network. Leadership with the highest level of authority is required to enable the formation of secure strategic partnership, build comprehensive planning capabilities, secure necessary resources, and handle conflicting interests across different agencies to sustain the governance of a multi-agencies network (Pardo & Burke, 2008a).

b. *Lack of legal authority to access data from multiple jurisdictions*. The lack of authority for access is magnified by the often overlapping fragmented regulatory structures. In addition, proliferation of complex hybrid financial products increases complexity of authority questions. The multiple jurisdictions governing the markets are recognized as obstructing the oversight of hybrid financial products (GAO, 2004). For example, state insurance regulators have limited ability to prevent individuals with serious criminal records from entering the insurance business in their states (GAO, 2004). This is because state insurance regulators lack authority to access FBI nationwide criminal records. Multiple jurisdictions also confuse consumers and limit regulators' ability to recognize early warnings of possible scams defrauding consumers. For instance, consumers might lodge a complaint about a hybrid product with a regulator who does not have authority over such product, thus resulting in an inadequate resolution of such complaint. The lack of a central body facilitating information sharing or negotiating agreements about what information could and should be shared means that the appropriate regulator is often left with a limited view of issues in the financial markets that impede their ability to deduce potential problems in the market (GAO, 1992). This situation creates two prominent challenges: duplication and overlap of regulation and competition among regulators to be the first to protect consumers and to appeal to the public (Pardo et al., 2011; Sayogo, Pardo, & Canestraro, 2011). This situation also challenges regulators themselves as they work to understand how firms are operating within the fragmented and overlapping systems of regulation (Pardo et al., 2011; Sayogo et al., 2011).

c. *Lack of enforcement action from the current sharing mechanism*. The Memorandum of Understanding (MOU) is the primary mechanism used to establish information sharing agreements. However, the MOU has been criticized for a lack of enforceable actions and a high reliance on the "soft power of persuasion" and willingness to cooperate (Brummer, 2010). The lack of coercive power in the current sharing mechanisms among the regulatory agencies could also create an opportunity for irresponsible actors to gain advantage by manipulating the system (Friedman, Jacobs, & Macel, 2003). In addition, high information asymmetries resulting from differences in legal systems, authority and jurisdictions, supervisory arrangements, social and moral habit, and competition among financial centers, undermine the effectiveness of MOUs at domestic (Friedman et al., 2003) and international levels (Brummer, 2010; Friedman et al., 2003).

d. *Legacy information systems impede access*. Different regulators maintain different and separate information systems and these different systems can significantly complicate routine information sharing. The integration of different legacy systems or the creation of interoperable systems out of existing legacy systems becomes a major hurdle (Pardo et al., 2011). Different legacy systems result in systems that "don't talk to each other" and create various "gold copies" of data (Pardo et al., 2011). Gold copies refer to the different data captured at different levels, organizations, and formats.

e. *Protection of sensitive data and information*. Financial regulators expressed concerns over the need to balance inclinations to share and the need to protect different types of regulatory information with varying degrees of sensitivity (GAO, 2004). Data protection becomes a major challenge in the financial markets (Pardo et al., 2011), although is not a unique problem to financial markets. Information security and protection are still major concerns in information sharing across federal agencies in general, thus making robust data protection policies a major issue. The development of information policies for information sharing and integration can be complicated by the tension among security, privacy and sharing needs as well as conflicting interests of multiple agencies. As found by Pardo et al. (2011), financial regulators often work to protect their own autonomy that can sometimes conflict with other regulators. Dawes (2010b) provides a useful framework for understanding information policies supporting information-based transparency initiatives. Dawes proposed a balancing of two complimentary requirements in the framework: information stewardship and information usefulness (Dawes, 2010a, 2010b). Stewardship "conveys the idea that all public officials and government organizations are responsible for handling information with care and integrity, regardless of its original purpose or source (Dawes, 2010b, p. 380)". Information usefulness, on the other hand, refers to the principle that the information

is not exclusively beneficial for a particular agency but for any agency (Dawes, 2010a, 2010b).

4.2.4. Trusted network

Systematic inter-organizational information sharing requires creation of networks consisting of agencies at different levels and sometimes might consist of organizations with overlapping business processes and non-standardized but similar information (Pardo & Burke, 2008b). The diversity of actors in this network could generate a range of potential conflicts of interest, which was found to be one of the primary challenges for information sharing in the FMR (Pardo et al., 2011). Tension exists among regulatory agencies with each striving to become or maintain their functional relevance to the market (Pardo et al., 2011; Sayogo et al., 2011). Consequently, enacting trusted relationships becomes a key element to ensuring systematic sharing. Despite the technological sophistication of systems, communication and information sharing still benefit from strong interpersonal capabilities.

To summarize, we identified twelve challenges that fit into the four components of the Gil-Garcia et al. (2010) information sharing framework. These challenges are 1) organizational culture, 2) leadership commitment, 3) capability to create effective collaboration, 4) capability to develop new systems and procedures, 5) ensuring data quality and integrity, 6) developing linked data, 7) collaborative governance structure and sharing strategies, 8) lack of legal authority to access data from multiple jurisdictions, 9) lack of enforcement action from current sharing mechanism, 10) legacy system impede access, 11) protection of sensitive data and information, and 12) enacting trusted relationships. We argue in the next section that these challenges affect different actors in the financial markets differently given the diversity of financial market stakeholders and their roles and interests in the market.

4.3. Understanding the connection between financial market actors, challenges and risks

This section correlates eight challenges with the primary actors in FMR. We combine four challenges – capability to create effective collaboration, capability to develop new systems and procedures, ensuring data quality and integrity and developing linked data – into two challenges. We also exclude two challenges — leadership commitment and enacting trusted relationship. Summary of this discussion is provided in Table 3.

The next section further explores the relationship between regulators and public by specifically discussing the implementation of smart disclosure policy in the FMR domain. We argue that implementation of smart disclosure policies could facilitate smarter governance of financial markets especially to manage the relationship between regulators and the public and in providing additional layers of monitoring in the market. Smart disclosure that allows for "release of data sets in usable forms that enable consumers to compare and choose between complex services… such that consumers can then use these data to make informed choices" (Sunstein, 2011), could reduce confusion by identifying relevant information that is needed to make informed choices. In the next section we demonstrate the benefits of finding solutions to the challenges of facilitating consumer understanding of government regulations, policies, and information in the financial sector through smart disclosure policies. We also discuss how information sharing challenges affect the development and implementation of smart mobile apps for financial data.

5. Smarter governance of financial markets: smart disclosure of financial data and public innovation

Financial markets constitute a complex system with a large number of mutually interconnecting and interacting parts (Pan, 2009; Sornette, 2009), which includes diverse agents and information. A complex system requires monitoring and oversight that assesses the whole picture as well as the component parts (Sornette, 2009). Such monitoring and oversight could be economically infeasible for governments to do by themselves. We posit that providing capability to combine data and information across different regulatory agencies through smart disclosure policies creates enormous value including benefits to the general public and for monitoring and oversight. We justify our argument through our evaluation of smart apps and tools for financial data. In particular, we present in-depth analysis of one exemplar of smart apps called BrightScope.

We argue that BrightScope and other information intermediaries could complement the effectiveness of monitoring and oversight conducted by financial regulators by creating additional layers of monitoring. Using smart apps for financial data, the general public could better understand the complexities of financial products thus minimize the occurrence of financial fraud and wrong investment decisions. These independent information intermediaries could overcome the problem of information overload, uncertainty of information and misperception of product information by transforming data and information available in public and private entities domain into manageable and easy to understand information. The ability of the general public to choose an investment decision wisely could protect them from fraudulent investment and possibility of loss and default. The key to this smart monitoring is in the availability of data and information needed by the information intermediaries.

In this section we demonstrate the benefits of cross-boundary information sharing in facilitating smarter disclosure of financial data and how such disclosure can support public innovation. We define public innovation as the development of new values, creative ideas and/or novel methods by the general public that is leveraging open data and is supported by information technology. We begin this section by outlining several types of financial data that is in the stewardship of government agencies, by showcasing the innovation potential of such data, and the wider potential that might be obtained from amassing and integrating available data. We then present the case of BrightScope to demonstrate the potential usage of open data and smart disclosure as well as the impact of challenges to cross-boundary information sharing to the development of smart public innovations such as BrightScope. We conclude the section with a discussion of the impact of cross-boundary information on facilitating smart disclosure of financial data.

5.1. Smart financial data and public innovation

Each financial regulator in the U.S. hosts large amounts of finance-related data pertinent to their own jurisdiction. For example, SEC is the steward of data related to the stock exchange, U.S. Commodity Futures Trading Commission hosts future trading data, and Federal Deposit Insurance Corporation stores enormous amounts of banking related data. Although the release of standalone data from each agency could benefit users, the ability to amass and triangulate data from different agencies results in greater potential innovative uses. Table 4 presents several examples of finance-related data in the custody of U.S. federal agencies.

Table 4 shows that expanding the availability and usability of standalone data and integrating it with data from other agencies could result in wider usage. As illustration, the Consumer Financial Protection Bureau (CFPB) collects data on consumer credit card complaints but does not verify the accuracy of all facts alleged in the complaints. Such data, while valuable, could be enriched by combining such data with information from other agencies or non-governmental sector. For example, BillGuard combines CFPB consumer complaint data with credit card complaints from banks and the web to provide consumers with information about hidden fees and billing errors (Rao, 2011). Regulators could use the same methods to identify areas for policy concerns. Similarly, the U.S. Department of Labor (DOL) collects and hosts retirement and employee benefit plan data. Analyzing data from DOL alone can

Table 3
Challenges, actors and risks.

Challenges	Government	SROs	Fin. industry actors	General public
Mitigating authority barriers — Lack of authority and cross jurisdictions	Limited ability to identify built-up vulnerabilities (IMF, 2007)	Limited ability to identify built-up vulnerabilities (IMF, 2007)	Confusion in filing complaints	Confusion in identifying relevant information (GAO, 2012)
Accommodating different organizational cultures	Resistance to change brought forth by new systems (Dawes, 1996; Pardo & Burke, 2008a, 2008b)	Resistance to change brought forth by new systems (Dawes, 1996; Pardo & Burke, 2008a, 2008b)		
Legacy systems and data interdependency impede access	Different metadata and formats inhibit integration and interoperability (O'Riain et al., 2012)	Different metadata and formats inhibit integration and interoperability (O'Riain et al., 2012)	Different reporting formats increase cost (Pardo et al., 2011)	Multiple points of access (Pardo et al., 2011)
Developing collaborative governance culture — involvement of high-level officials and political leaders	Conflicting interests among regulatory agencies — the competitiveness and risks of being relevant to the market (Pardo et al., 2011)	Conflicting interests among regulatory agencies — the competitiveness and risks of being relevant to the market (Pardo et al., 2011)		
Developing linked data and a common language — Ensuring data quality and integrity	Investment to ensure data quality in large datasets (Pardo et al., 2011)	Investment to ensure data quality in large datasets (Pardo et al., 2011)	Investment to ensure data quality for compliance (Pardo et al., 2011)	Distortion due to low quality data.
Protection of sensitive data and information, balancing usefulness and stewardship	Liabilities of privacy and proprietary data and information (Pardo et al., 2011)	Liabilities of privacy and proprietary data and information (Pardo et al., 2011)	Liabilities of privacy and proprietary data and information (Pardo et al., 2011)	Security of personal data
Lack of enforceable action for the current information sharing mechanism	Dependence on the "goodwill" of counterparties (Brummer, 2010; Friedman et al., 2003)	Dependence on the "goodwill" of counterparties (Brummer, 2010; Friedman et al., 2003)	Opportunities to manipulate the system	Higher vulnerability to fraud and exposures
Developing capabilities for collaboration and developing new procedures	Gaps in capabilities that hamper collaboration (Pardo & Burke, 2008a, 2008b)	Gaps in capabilities that hamper collaboration (Pardo & Burke, 2008a, 2008b)		

Intersection of challenges and actors represents the risks.

yield values such as comparison of investments offerings and fees from different retirement and investment plans. On the other hand, triangulating the DOL data with investment and company disclosure information collected by SEC enables comparison, evaluation and rating of the different investments offering as is being offered by BrightScope.

Facilitating the development of public innovation by smart disclosure of financial data such as BrightScope or BillGuard requires agencies to have capability to open the data to the public. The next sub-section presents the case of BrightScope to highlight the challenges to cross-boundary information sharing that entrepreneurs encounter when developing financial apps and tools.

5.2. The information challenge of developing smart financial apps: the case of BrightScope

BrightScope is a start-up technology company established by Ryan and Mike Alfred in 2009. BrightScope was considered one of the best examples of Gov 2.0 in 2010 by former U.S. CTO, Aneesh Chopra (Howard, 2010) and continues to be viewed as one of the success stories of smart disclosure implementation in the financial domain (Howard, 2011; Lieber, 2011).

BrightScope offers two major services. First, it provides a complete list of all corporate and government 401(k), 403(b) and 457 retirement plans and the performance rating of each plan. Two rating levels are used: a blue ribbon and a red ribbon. A plan which receives a blue ribbon is considered the top plan in each peer group; one that receives a red ribbon is part of the top 15% of plans in each peer group (Fig. 2). Clicking any company name in BrightScope generates a page (right hand side in Fig. 2 below) with detailed information on the retirement plan and company performance with regard to the retirement plan offerings. Second, BrightScope provides a complete financial advisor directory with the similar rating structures as the retirement plans directory.

The founders of BrightScope faced numerous challenges as they worked to build their system. The challenges, detailed in several publications and news articles such as O'Reilly, the New York Times and other news blogs, were related to data access and availability, data format, and data quality. A lack of data access and availability were the first challenges faced. The founders of BrightScope discovered that the data they sought was not always available or were available in a format or quality below their expectation. For instance, the 401(k) data for 2009 was not readily available. As a consequence, initial data for the 401(k) plans had to be gathered through 50 Freedom of Information Act (FOIA) requests to the Department of Labor; the data arrived in boxes of paper (Howard, 2010; Lieber, 2011). This data gathering process was expensive in terms of resources and time.

The founders also cited the challenge of obtaining data on financial advisors. This data was locked in the SEC's Investment Adviser database and FINRA's BrokerCheck databases (Toonkel, 2011). As cited by Howard (2011), the founder of BrightScope stated that "…data was there because we were advisors…we knew data had been filed but it wasn't clear what was being done with it…" The founders also pointed out that the data was not complete, "FINRA and SEC wouldn't give a listing by identifier", which made it difficult for the founders to figure out how large the financial advisor's realm is in the U.S. (Howard, 2011).

The second set of challenges facing BrightScope was data format. The data was not in digitized form. While the U.S. Federal Government was rolling out its data portal, data.gov, the Department of Labor still had not published online the information BrightScope needed (Howard, 2011). To change this, the founders focused their next efforts on searching for and lobbying for digitized data. They launched lobbying campaigns for data to be disseminated in digitized form (Howard, 2010), sending out emails coaxing influential people to persuade the Department of Labor to release data in electronic format (Lieber, 2011). After a nine month campaign (Lieber, 2011), they received the requested data in electronic form, but in PDF format (Howard, 2010).

The last challenge faced by the founders of BrightScope was ensuring data quality. A poll conducted by InvestmentNews of the 205 financial advisers indicated that the majority of the respondents (84%) claimed that BrightScope's data was incorrect (Lieber, 2011). The financial advisers especially questioned the accuracy of the AUM (Assets Under Management) data claiming that the data presented in BrightScope was not correct (Southall, 2011). In response to the claims, the founders proposed that the error likely came with the data when it was acquired from SEC and FINRA (Lieber, 2011).

5.3. The relationship of cross boundary information sharing to smart disclosure of financial data

The BrightScope story points to three challenges of information sharing in terms of a) access, b) availability of data in machine readable format and c) completeness and quality of data. These challenges indirectly correspond to the capabilities of government agencies to facilitate open data by enabling information sharing and integration across agencies.

The first challenge facing BrightScope was information access and digital availability. Following the framework and challenges presented in Section 4.2. above, these challenges correspond to that of developing information sharing and integration capability. In the article by Howard (2010), data.gov evangelist – Jeanne Holm – offered to help DOL get data to data.gov as a way to alleviate the challenges faced by BrightScope in getting access to data in digital form (Howard, 2010). The case and response from Ms. Holm, suggestively indicates the impact of cross boundary information challenges on government agencies capability to provide needed data. Considering the data in question at that time (401 k investments) was developed by three agencies, this situation also shows suggestive evidence of challenges to creating effective collaborations and related governance structures. As argued by Pardo, Gil-Garcia, and Burke (2008) and Pardo, Gil-Garcia, and Luna-Reyes (2008), information sharing necessitates the creation of an effective collaborative governance structure and capability to create effective collaboration (Pardo, Gil-Garcia, & Burke, 2008).

Table 5 presents the number of data sets pertinent to financial markets that were available in data.gov as of April 2013. This data from major regulators in the financial markets, further illustrates the importance of addressing the challenges facing cross-boundary information sharing as the foundation of open data and smart disclosure.

Data.gov represents an effort to share information across government agencies to create a single data repository for public to use. In 2010, the founders of BrightScope indicated that they could not find sufficient data in data.gov for their uses and they must go to the source agencies to get the data they seek (Howard, 2010). As presented in Table 5, the datasets published by financial regulators per April 2013 are limited thus suggesting that the issue of data sufficiency might still persist. This implies the likelihood that users who have a need for financial data have to acquire that data directly from the source agency.

BrightScope also faced challenges in terms of data completeness and data quality. These challenges also correspond to the challenges of cross-boundary information sharing and integration. Interview findings from Pardo et al. (2011) indicate that data management and processing to ensure sufficient quality of the data can be an overwhelming task (Pardo et al., 2011). Cross-boundary information sharing presents a triangulation capability. As shown from the existing innovative smart disclosure apps, capability to triangulate from different sources of data complement the shortcomings of data from standalone resources.

6. Discussion and implications

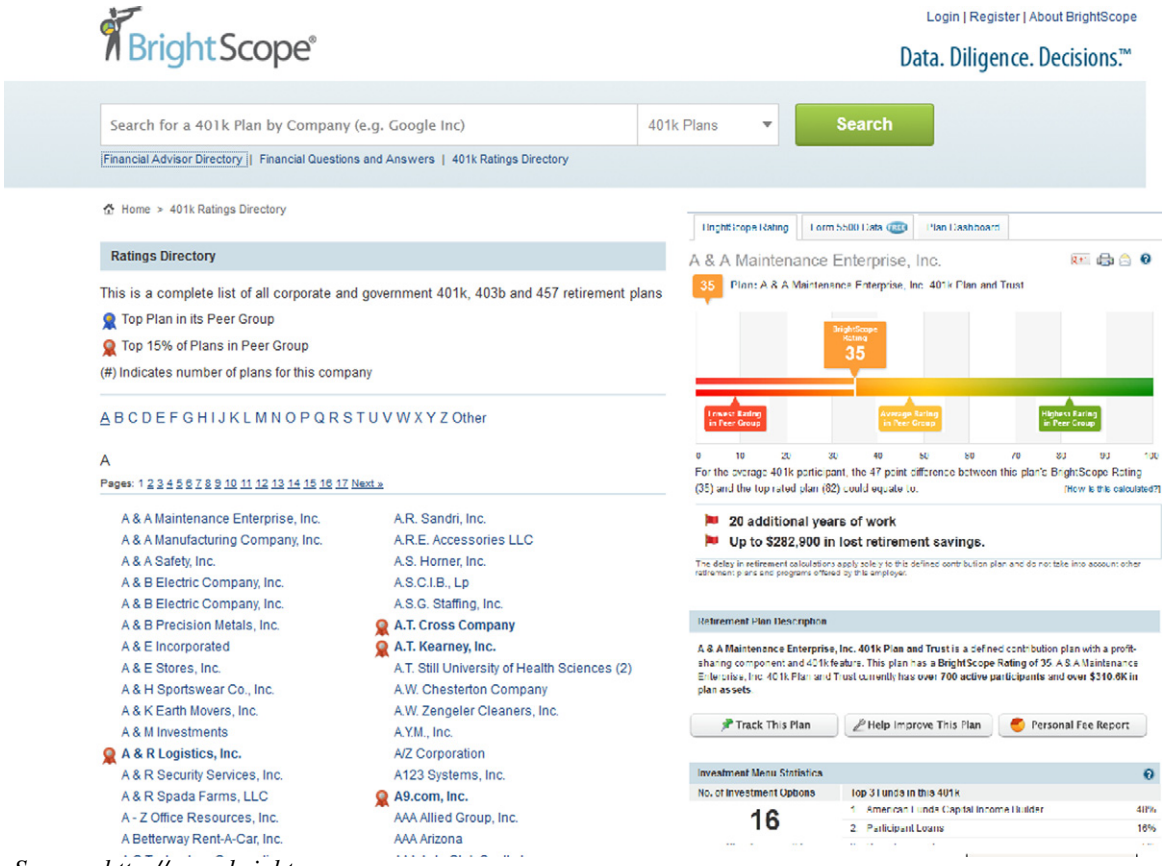
This paper makes an argument for the criticality of effective cross-boundary information sharing to financial regulators seeking to establish robust governance of financial markets. This paper discusses and reviews the already-documented literature on inter-agency information sharing and integration in FMR. We posit that understanding the challenges to cross-boundary information sharing among financial regulators is a critical step in building an efficient market and reducing the risk of future crises. This paper combines a literature review with a case study of smart innovation of financial data called BrightScope. Innovations such as BrighScope are the result of integration of data and information in the custody of government, not-for-profit organizations and private firms. According to Gil-Garcia (2012), such innovative settings based on collaboration and integration of data and information from different sources can be defined as part of an initiative for smart government or smart state (Criado, Sandoval-Almazan, & Gil-Garcia, 2013). As presented in this paper, the use of smart applications can help consumers better understand the complexity of financial products and make more informed investment decision. Additionally, information intermediaries, through smart apps, could complement the monitoring and oversight provided by financial regulators by creating additional layers of monitoring.

The final section of this paper suggests future research directions and practical advice for government managers to help them understand the challenges to and build the capability needed for systematic information sharing in financial markets.

a. *Identifying the necessary capability to share information*
   As argued in this paper, creating systematic information sharing across organizations is a non-trivial process. There is a variety of challenges confronting the creation of systematic information sharing. We argue that an understanding of these challenges is the foundation to identify and build the necessary capability to share information among regulators. For instance, sharing could be made easier if government managers have the capability to create effective collaboration, capability to develop new systems and procedures and capability to ensure data quality and integrity. The existence of these capabilities could incentivize data and information custodians to share their data and information. Further, barriers to sharing can be mitigated if the organizational culture supports sharing, for example training to ensure the development of a sharing culture can be crucial.
b. *Designing sharing policies and strategies that enable effective and systematic sharing*
   Protection of information and data is a major challenge to inter-agency information sharing, including across financial regulators. Information policies that smartly deal with the three exceptions to disclosure — privacy, secrecy/confidentiality/proprietary and national security are required. Disclosure policy that smartly manages the three issues of disclosure could encourage sharing. Building from the challenges identified in this paper and the evaluation of the smart apps cases, we propose several policies and strategies that government managers could consider.
   - Formalizing data and information governance at the highest level of the agency. Rules and procedures for sharing the data and control of the data need to be established at the highest levels.
   - Re-evaluating existing legal boundaries with regard to information disclosure. Existing legal boundaries need to be re-evaluated and collaboration across jurisdictions needs to be enforced with regard to what data may be published, when the data should be published and who should publish the data. This approach is needed to overcome the challenges of multi-jurisdictions and legacy systems. For this approach to be successful, there needs to be a change in the perspective of sharing data from short-term, protecting agency own turf and reputation, to long-term, protecting the financial markets as a whole. This change in perspectives could eliminate the potential conflict of interests among regulators and other interested actors.
   - Enforcing “Fitness for Use” for data and information sharing. The information strategies and policies need to be driven by the analytical needs. The involvement of public and information

Table 4
Selected finance-related data and it's smart use.
Source: Adapted from highlights.data.gov

Data category	Agency	Types of data	CBIS issue & other data points	Smart use
Consumer credit card complaints	Consumer Financial Protection Bureau (CFPB)	• Open data • 15,000 anonymized complaints • Data is refresh daily • Data includes: name of credit card provider; types of complaints; date and zip code • CFPB does not verify the accuracy of all facts alleged in the complaints	• Need other data point to verify the accuracy • Other possible data point include: Banks, Consumer bureau, Better Business Bureau, FDIC or Web	• BillGuard combine this data with web and banks data to find gray charges on users [current] • Agency could triangulate several data points to identify repeated fraud occasion [potential regulatory usage]
Retirement and employee benefit plan data	Department of Labor (DOL)	• Open Data • Form 5500 Annual Report • About 800,000 401(k) plans and other employer-sponsored retirement and welfare benefit plans across the United States • Jointly developed by the Department of Labor, the Internal Revenue Service, and the Pension Benefit Guaranty Corporation	• SEC investment disclosure • State Insurance Agency — Insurance company data	• BrightScope: provide rating on 401(k) and 403(b) plans based on Form 5500 and SEC investment disclosure data [current]. • Personal Capital: compare investment offerings and fees from different retirement and investment plants [current] • Agency could use the comparison of different investment ratings and fees to develop policy [potential regulatory usage]
Financial advisor data	• SEC • FINRA • State Insurance Agency	• Name of financial advisor • Demographic information • Amount of assets • Fees • Disciplinary actions	• Comparability is difficult across different financial advisors • Data is separated based on jurisdictions, for example: advisor for insurance is under State Insurance Agency • Consumers have to amass large number of data • Standardization of data is not available	• BrightScope: provides data on financial advisers including rating on their rating on the financial advisers amassing data from SEC, FINRA and State Insurance Agency [current usage] • Agency could map the disciplinary actions and rating of advisors across all types of financial products [potential regulatory usage]
SEC data on public companies and mutual funds	• SEC	• Financial statement in XBRL formats • Mutual fund fee, risk and return information	• Data is standardized using XBRL format but consumers have to amass large number of data	• CalcBench: facilitate investors with tool to analyze, compare and understand financial reports from different companies [current usage] • SigFig: provides users personalized advice on investments and fees based on mutual funds and exchange-traded funds data [current usage] • FindTheBest provides users side-by-side comparisons of different finance products [current usage] • SEC has been implementing comprehensive and almost real-time monitoring and oversight through effort like CAT [current regulatory usage]



Source: http://www.brightscope.com

Fig. 2. BrightScope 401(k) page.

intermediaries as additional layers of monitoring need to be imposed to enable the bottom-up needs identification.

c. *Research implications*

We conclude our discussion by calling for attention to a number of areas in which computer and information science research can further our exploration of information and knowledge sharing to support governance of financial markets. Such explorations can involve analyses of the types of information and knowledge that should be shared between the actors in financial market regulation. For example, better analytical tools could build on formal specifications of trading data and financial actors' behavior. High level languages for identifying patterns of interest (e.g., fraud signatures) in financial data streams should enable highly scalable, real-time analysis of data streams to support decision making (O'Riain et al., 2012). As another example, data mining approaches are essential to detecting patterns of activity that produce anomalous market behavior, such as the May 2010 "flash crash,[2]" or identify the possibility of manipulative or fraudulent practice that warrant further investigation. Predictive data mining could be useful for identifying impending market destabilization or manipulation and developing better "circuit breakers.[3]" Social network analysis could be used in combination with structured data to provide evidence of individuals or organizations engaged in inappropriate activities. The ensuing research should lead to new models of computing, system design and data analysis that can improve practices in this important and challenging domain.

d. *Limitations*

In this paper we provided a brief comparison of several cases of smart apps to demonstrate the innovation potential of opening financial data and smart disclosure. In addition, we specifically reviewed a single case of a smart apps exemplar called BrightScope. We believe that complementing one in-depth case evaluation with a brief comparison of several smart apps is sufficient to support our argument of the potential of smart innovation in FMR. However, we acknowledge that providing more in-depth evaluation of multiple cases will provide stronger support for our argument about the impact of information sharing challenges on the development of smart apps. Thus, we propose that future research could compare several case studies in-depth to ascertain the result of this study in evaluating the information sharing challenges in FMR.

[2] Flash crash is the US stock market crash in May 2010 when "the Dow Jones Industrial Average suffered a stunning 1000-point loss (9%) in 5 min, followed by an equally dramatic recovery http://www.forbes.com/sites/deborahljacobs/2013/08/09/why-we-could-easily-have-another-flash-crash/".

[3] Circuit breakers are steps to halt trading when "a major stock or commodities exchange stops trading temporarily because an index, or even an individual stock, has fallen a certain percentage during a trading day" to avoid price free fall http://www.cnbc.com/id/44059883.

Table 5
The number of financial market-related data in data.gov by agency (April, 2013).

Agencies	# of Data
Commodity Futures & Trading Commission	3
Security Exchange Commission	21
Federal Deposit Insurance Corporation	3
Federal Housing Finance Agency	6
Federal Reserve Board	5

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